Workgroup Consultation

GC0141: Compliance Processes and Modelling amendments following 9th August Power Disruption

Overview: The events of 9 August 2019 unfolded when a transmission circuit faulted, and clearance caused unexpected losses of User's Plant and Apparatus. The consequence of this high level of generation loss led to the first stage of the low frequency demand disconnection scheme operating, which then led to approximately one million customers losing their electricity supply. Subsequent investigations by BEIS and Ofgem recommended that the processes for demonstrating compliance of new and long-term Users with the Grid Code and the modelling information from Users should be improved.

Modification process & timetable

1. **Proposal form**
   - 14 March 2020
2. **Workgroup Consultation**
   - 09 March 2021 - 30 March 2021
3. **Workgroup Report**
   - 30 April 2021
4. **Code Administrator Consultation**
   - 4 May 2021 - 25 May 2021
5. **Draft Code Modification Report**
   - 24 June 2021
6. **Final Code Modification Report**
   - 28 June 2021
7. **Implementation**
   - 1 October 2021

Have 5 minutes? Read our Executive summary

Have 20 minutes? Read the full Workgroup Consultation document

Have 30 minutes? Read the full Workgroup Consultation document and annexes

Status summary: The Workgroup are seeking your views on the work completed to date to form the final solution(s) to the issue raised

This modification is expected to have a: high impact on Generators and HVDC Interconnector Owners.

Modification Drivers: GB Compliance

Governance route	This modification has been assessed by a Workgroup and Ofgem will make the decision on whether it should be implemented	
Who can I talk to about the change?	**Proposer**: Mark Horley Mark.Horley@nationalgrideso.com Phone: 07733 301519	**Code Administrator Chair**: Joseph Henry Joseph.Henry2@nationalgrideso.com Phone: 07970 673220
How do I respond?	Send your response proforma to grid.code@nationalgrideso.com **by 5pm on 30 March 2021**	

Executive Summary

The Government (BEIS) and the Regulator (Ofgem) investigated and reviewed the incident of 9th August 2019 when some 1 million customers lost their electricity supply as a consequence of unexpected losses of generation following a correctly cleared fault event on the Transmission System. The modifications included in these proposals are to address the concerns raised in Action 3 of the Ofgem Report and Action 2 of the BEIS report.[1]

What is the issue?

The events of 9 August 2019 unfolded when a transmission circuit faulted, and clearance caused unexpected losses of User's Plant and Apparatus. The consequence of this high level of generation loss led to the first stage of the low frequency demand disconnection scheme operating, which then led to one million customers losing their electricity supply. Subsequent the investigations by BEIS and Ofgem resulted in the following headline action: "The ESO, in consultation with large generators and transmission owners, should review and improve the compliance testing and modelling processes for new and modified generation connections, particularly for complex systems"

Within the Ofgem report detailed concerns were raised relating to the robustness of the processes for demonstrating compliance of new and long- term Users, lack of independent oversight and ability to model dynamic behaviour of complex systems.

What is the solution and when will it come into effect?

Proposers solution:

To improve modelling the proposal includes drafting to specifically require the submission of controller models appropriate for the new technologies and systems and add in a requirement to allow this information to be shared with other relevant Users (e.g. HVDC Converter stations, large converter-based wind farms) to allow interaction studies required under EU Code to be completed prior to connection. in the new requirements for models include scope, technical description, performance, validation, documentation and sharing.

Clarify the fault ride through compliance requirement to ensure that not only the fault period is ridden through but also that the plant remains connected and recovers acceptably across the range of frequency and voltage recovery which can follow fault clearance". To improve the compliance process for complex connections the proposals extend the scope of fault ride through simulations carried out prior to connection for large/complex wind farms and HVDC. This had been included in GC0138 as well but has been considered in the context of GC0141 due to direct relevance to the Ofgem action.

Create a new section "Compliance Repeat Plan" within the Grid Code for Users to confirm compliance with their Grid Code obligations to National Grid ESO every 5 years.

Concerns were raised by Ofgem that there is no independent involvement in the compliance process. Therefore, this proposal seeks to add in a requirement that all

[1] https://www.ofgem.gov.uk/system/files/docs/2020/01/9_august_2019_power_outage_report.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/855767/e3c-gb-power-disruption-9-august-2019-final-report.pdf

simulation reports are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO. This proposal explains the extent of the independent engineer's responsibilities.

Implementation date:

1 September 2021

Summary of potential alternative solution(s) and implementation date(s):

Alternative solutions are being raised to address the following areas of the Original proposal. They have been detailed at a high level in this document.

What is the impact if this change is made?

This change relates to the Grid Code Planning Code (PC), Connection Conditions (CC), European Connection Conditions (CC), Compliance Processes (CP), European Compliance Processes (ECP) and Data Registration Code and may require subsequent update to STC Section K and STCP19-5 for consistency.

The proposals will improve consumer value by making compliance and modelling processes more robust reducing the risks of power supply disruptions to customers.

Interactions

Offshore Networks are designed in conjunction with the design of offshore generation so dependent upon the point at which OTSDUW entities transfer assets into the emergent OFTO, or in cases where an OFTO is already in placed there will be the need to update STC Section K and STCP19-5 to align with the Grid Code proposals.

Contents

What is the issue?

The BEIS report (Action 2) and Ofgem Report (Action 3) asked that the compliance processes and modelling processes for new and modified generation connections, particularly complex arrangements, should be reviewed and improved.

What

Considering the events of 9th August 2019, National Grid ESO has identified the following areas of the Grid Code which may be considered as defective:

i) Since the Grid Code was modified in June 2005 through modification (H/04) to cover convertor-based technology (including HVDC plant) there has been a huge growth of this plant and apparatus connected to the transmission system with increasingly complex connection arrangements. Past Grid Code modifications (GC077) relating to the submission of shaft data from new Synchronous Generation to allow torsional interactions (SSTI) to be studied have been found to be causing delays to the connection of new power sources as data is needed from existing Generators. The current Grid Code obligations for supplying controller/converter dynamic modelling information are also considered inadequate to ensure secure operation of the power system particularly regarding to convertor base technology phenomena such as Sub Synchronous Controller Interaction (SSCI). The Grid Code modification GC0100 also assigned responsibilities on Users to carry out studies for these interactions (see ECC.6.3.17) prior to connection which require National Grid ESO to share modelling information, a requirement which is currently not included in the Grid Code.

ii) Defining Users' obligations to ride through fault events on the transmission system and remain in operation after a fault clearance is considered to be lacking clarity.

iii) While Users consider each minor modification to their Plant and Apparatus in isolation, it may not be apparent that the overall performance of the Plant and Apparatus has changed over its lifetime as a result of the accumulation of these small changes. The consequence is that older plant may not perform as expected when subjected to one of the rare severe events which can occur on the transmission system and the models used by National Grid ESO may no longer be correct.

iv) Convertor based technologies are often installed in complex networks which may be subject to different configurations during commissioning and the lifetime of the site when individual plant items are out of service. The Grid Code does not specifically require Users to study and demonstrate that connection arrangements across all intended operating conditions of those networks comply with fault ride though requirements. This defect has also been raised under Grid Code Modification GC0138.

v) Concerns were raised by Ofgem that there is no independent involvement in the compliance process.

How

National Grid ESO is proposing that the following areas of Grid Code should be discussed for possible modification:

i) The Planning Code should be updated to require shaft data from all Synchronous Generation connected to the transmission network. National Grid ESO recognises that there will need to be a time period to allow Users to supply this information. The Planning Code should also be updated to specify the plant and apparatus models to be submitted to National Grid ESO.

ii) Additionally, the Planning code should be updated to clarify the format of the model information required (Root Mean Square (RMS) and Electromagnetic Time domain (EMT)) required for al HVDC and generation connected to the transmission network, and for other large generation. This includes- (for RMS models) use of industry standard software model templates with site specific parameters as options with a requirement for these to be shared with relevant Users and (for EMT) how the models may be shared to enable industry to perform necessary studies while protecting intellectual property rights.

ii) Update the wording of the Connection Conditions and European Connection Conditions describing Fault Ride Through to ensure the requirements apply during and after the fault.

iii) The proposal is to update the Compliance and European Compliance Processes sections of the Grid Code to oblige Users to confirm their Plant and Apparatus is compliant at regular (5 year) intervals during the life of the asset. This is consistent with European legislation “Requirements for Generators” (Article 41 paragraph 2) for regular re-evaluation of User compliance with the Grid Code.

iv) Update the Compliance and European Compliance Processes simulation sections of the Grid Code (CP & ECP) to oblige Users with complex networks to provide simulations for reasonably anticipated operating conditions.

v) Update the Compliance Processes simulation sections of the Grid Code (CP & ECP) to require Users to have the simulation studies reviewed by an independent engineer or test body prior to submission to National Grid ESO. The obligations for compliance and assessment of compliance remain with the User and National Grid ESO (or TO if applicable) respectively.

What is the solution?

Proposer’s solution:

(i) Improvement to Model Submission - PC

Remove the wording relating to a Completion Date of 01 April 2015 in the wording of PC.A.5.3.2(g) to require all synchronous generators to supply shaft stiffness data to allow Sub Synchronous Torsional Interaction studies to be carried out. Add a sentence to allow this information to be shared with other relevant Users (e.g. HVDC Convertor stations**,** large convertor-based wind farms) to enable the User to carry out such studies. Add a new section (PC.A.9) to give detailed RMS and EMT Model requirements including scope, technical description, performance, validation, documentation and sharing. This is consistent with recent updates to modelling practices internationally (e.g. Australia, Ireland) based on power disruption incidents.

(ii) Clarify wording on Fault Ride Through

To add further clarity on the interpretation of FRT requirements, it is proposed to add a new sentence on the first paragraph of the CC fault ride through compliance requirement. This new sentence explains the circumstance of how long the generator or HVDC System would be expected to remain connected and stable after a transmission fault. The format of the ECC is different so a change of words in three clauses is required.

CC

Amend the wording of CC.6.3.15 to include an additional sentence "For the avoidance of doubt, for up to 30 minutes following such a fault or disturbance **Generating Units**, **Power Park Modules**, **DC Converters** and **OTSDUW Plant and Apparatus** are required to remain connected and stable provided system operating conditions have returned within those specified in CC.6.1"**.**

ECC

Add the following sentence to the wording of ECC.6.3.15.2:

"For up to 30 minutes following such a fault event each **Power Generating Module**, **Power Park Module**, **HVDC Equipment** and **OTSDUW Plant and Apparatus** is required to remain connected and stable provided system operating conditions have returned within those specified in ECC.6.1."

Add the following subsection to the wording of ECC.6.3.15.9.2.1(a):

"(iv) For up to 30 minutes following such a **Supergrid Voltage** dip on the **Onshore Transmission System** each **Synchronous Power Generating Module** is required to remain connected and stable provided system operating conditions have returned within those specified in ECC.6.1.,"

Add the following subsection to the wording of ECC.6.3.15.9.2.1(b):

"(iv) For up to 30 minutes following such a **Supergrid Voltage** dip on the **Onshore Transmission System** each **Power Park Module** and **OTSDUW Plant and Apparatus** is required to remain connected and stable provided system operating conditions have returned within those specified in ECC.6.1."

(iii) Repeat Confirmation of Compliance

Create a new section "Compliance Repeat Plan" within both the CP and ECP. This new section will require Users to confirm compliance with their Grid Code obligations to National Grid ESO every 5 years.

The 5 years will be from the date of issue of the latest Final Operational Notification which maybe after a user has completed the initial connection compliance process (EON/ION) or the compliance process following a change or defect (LON).

The section would set out a process for National Grid ESO to contact the User not less than 6 months before the date when compliance confirmation is required.

The section would set out that in order to confirm compliance, Users will be required to submit:

- a Compliance Statement and a User Self Certification of Compliance;
- a complete set of Planning Code data (both Standard Planning Data and Detailed Planning Data);

The section would set out that if a User is unable to confirm compliance or recognises that changes have been made which may have impacted on performance then the Limited Operational Notification (LON) process would be started. This is the mechanism acknowledged in CP.8.1(i) and ECP.8.1(i).

Adding a new section requires renumbering of subsequent sections of the CP and ECP along with corrections to the cross referencing. Additionally, the following more substantial changes are made.

CP

Amend the wording of CP.7.4 to include an additional sentence:

"the **Final Operational Notification** will be subject to Compliance Repeat Plan no later than 5 years from the date of issue." Insert the new section in the CP after Final Operational Notification (CP.7) and before Limited Operational Notification. As a consequence, renumber sections Limited Operational Notification to CP.9, Processes Relating to Derogations to CP.10 and Manufacturers Data & Performance Report to CP.11 and update all cross referencing.

Revise the wording of CP.8.5.6(e) as follows:

"~~an interim a~~ final **Compliance Statement** and a **User Self Certification** of **Compliance** completed by the **GB Code User** (including any **Unresolved Issues**) against the ~~relevant~~ Grid Code requirements including details of any requirements that the **Generator** or **DC Converter Station** owner has identified that will not or may not be met or demonstrated; and"

so that a condition of receiving a Final Operational Notification following a Limited Operational Notification clearly includes full confirmation of compliance.

ECP

Amend the wording of ECP.7.4 to include an additional sentence

"the **Final Operational Notification** will be subject to a Compliance Repeat Plan no later than 5 years from the date of issue."

Insert the new section in the ECP after Final Operational Notification (ECP.7) and before Limited Operational Notification. As a consequence, renumber sections Limited Operational Notification to ECP.9, Processes Relating to Derogations to ECP.10 and Manufacturers Data & Performance Report to ECP.11 and update all cross referencing.

Revise the wording of current ECP.8.5.6(e) as follows:

"~~an interim~~ a final **Compliance Statement** and a **User Self Certification** of **Compliance** completed by the **User** (including any **Unresolved Issues**) against the ~~relevant~~ Grid Code requirements including details of any requirements that the **Generator**, **HVDC System**, **Network Owner** or **Non-Embedded Customer** owner has identified that will not or may not be met or demonstrated; and"

so that a condition of receiving a Final Operational Notification following a Limited Operational Notification clearly includes full confirmation of compliance.

(iv) Additional Fault Ride Through Simulations

CP

CP.A.3.5 Additional FRT studies for different operating scenarios. Additional paragraphs requiring complex Power Park Modules and HVDC installations to carry out FRT studies for a fair representation of a depleted network and operating scenarios e.g. export cable and/or primary transformer outages.

ECP

ECP.A.3.5 Additional FRT studies for different loading/commissioning scenarios. Additional paragraphs requiring complex Power Park Modules and HVDC installations to carry out FRT studies for a fair representation of a reasonable depleted network and commissioning scenarios e.g. export cable and/or primary transformer outages.

The above were also proposed under GC0138 but are more directly related to the E3C Actions.

(v) Independent Engineer

CP

CP.A.3.1.2 Additional wording requiring that all reports are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO and explaining the extent of the independent engineer's or independent test body's responsibilities.

ECP

ECP.3.1.2 Additional wording requiring that all reports are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO and explaining the extent of the independent engineer's or independent test body's responsibilities.

Workgroup Considerations

The Workgroup convened 6 times to discuss the perceived issue, detail the scope of the proposed defect, devise potential solutions and assess the proposal in terms of the Applicable Code Objectives.

Original Proposal – High Level Summary

The original proposal suggested a number of separate changes to the Grid Code for the industry to consider against the BEIS/Ofgem action to make the compliance and modelling processes for generation more robust. In summary the five solution areas were:

To improve the robustness of the modelling process the proposal added requirements Users to provide RMS and EMT software models including scope, technical description, performance, validation, documentation and confidentiality. The proposal includes sharing modelling information with other relevant Users (e.g. HVDC Converter stations, large converter-based wind farms) to allow interaction studies to be completed prior to connection.

To improve Generator understanding of the fault ride through obligations the description of fault ride through requirement was modified.

To improve the robustness of large wind farms during the commissioning process the scope of fault ride through simulations carried out prior to connection for large/complex wind farms and HVDC was increased to include alternative running arrangements.

To improve the robustness of lifetime compliance of Users with older plant, a new section "Compliance Repeat Plan" was added within the Grid Code for Users to confirm compliance with their Grid Code obligations to National Grid ESO every 5 years.

To address concerns raised by Ofgem that there is no independent involvement in the compliance process add in a requirement that all simulation reports are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO. The proposal explains the extent of the independent engineer's responsibilities.

Consideration of the proposer's solution

In order to drive initial conversation in the workgroup, the proposer shared his initial legal text and thinking around the modification and invited comment from workgroup members

on the proposed wording of several aspects of the solution. It was noted by the Workgroup that there were some crossovers with GC0138, and that certain elements of discussions in regard to this modification may sit better under GC0138 *Compliance process technical improvements (EU and GB User).* The two modifications are being assessed by the same workgroup.

The Workgroup spent much time scrutinising the initial proposal and legal text put forwards by the solution and the workgroup had several opportunities to provide comment on the text produced by the proposer. This feedback was taken onboard throughout October 2020 and a final Original Solution was produced by the Proposer, incorporating as much of the Workgroup's feedback as possible.

The legal text for the Original Solution is included in Annex 3 of this report.

Despite amendments and feedback being incorporated into the legal text of the Original Solution, there remained some points of contention within the Workgroup. As such, prior to this consultation, a few workgroup members indicated that they may wish to raise alternative solutions post consultation. The workgroup would be interested to hear the thoughts of industry on any areas of contention highlighted within this report and remind industry that as part of this consultation, they are able to raise their own alternative solutions.

Approach taken to assessing workgroup feedback on the Original Proposal

The workgroup discussed comments provided on the legal text for both GC0138 and GC0141. The Code Administrator addressed workgroup concerns around comments and feedback given being addressed in the development of the original solution. The workgroup attributed a RAG status to comments made and the ESO took an action away to address these comments and develop a draft version of the original solution.

The workgroup was advised on the process of raising alternative solutions, which could potentially become Workgroup Alternative Grid Code Modifications. The workgroup was asked to begin thinking of alternative solutions if there were any discrepancies between their understanding of the modifications and those put forwards in the original solution.

Suggestions for alternative solutions were forthcoming from National Grid Ventures but are not officially raised yet. These will be highlighted as part of this consultation and your views sought on their feasibility.

Independent Engineer Verification

In the Original solution put forward by the proposer, the additional requirement for Independent Engineer verification was included. The ESO, as proposer, believe that the additional requirement for Independent engineer verification as part of this modification goes some way to ensuring the future robustness of arrangements going forwards. The opinion within the workgroup differed somewhat, however, as concerns were raised about the logistics of this, and cost to industry. Some concerns were raised in regard to the additional risk this may add, as well as discussions regarding the level of value it could add.

Ofgem gave an update on their thinking on the requirements for an Independent Engineer Verification prior to this consultation. An element of the workgroup felt that it would be difficult to find appropriate independent resources and cost of doing so would be significant. The general feedback from the majority of the workgroup was that there

was no requirement nor distinct benefit in utilising an Independent Engineer. Ofgem at this point suggested that ESO could do with having more in-house resources available who can then review and suitably challenge the studies. Ofgem's proposal was that the workgroup proposes some suggested solutions to demonstrate more enhanced, robust and a more economical process.

The feedback and comments provided by the workgroup made clear that any such reviewing process could include suitable individuals who are not directly involved in the design of the project, but not necessarily independent of the company. Opinion within the workgroup also suggested that this could be undertaken by the ESO.

The proposer had sympathy with the workgroup view that the requirement for seeking third party approvals to studies and test results adds unnecessary cost and further potential problems with confidentiality issues. Furthermore, the responsibility for compliance remains with the user. It should be noted however that the proposed original solution contains a revision to the Independent Engineer clause. The view of the ESO is that the they should be employed by the Generator to review the study work which will be submitted to the ESO and not to undertake other works related to the particular project for which the studies are being reviewed.

The proposer explained that the scope of the Independent Engineer's oversight is to reassure that the studies reasonably represent behavior of the plant and apparatus, that the test scenarios are in accordance with the Grid Code requirements and that appropriate results are presented in the reports to demonstrate compliance. The assessment on whether the results do demonstrate compliance remains the responsibility of the Generator and ESO.

The proposer of the original solution has made it clear that this solution will maintain the requirement for Independent Engineer Verification and as such has drafted the legal text outlined in Annex 2 accordingly. The workgroup would welcome thoughts in regard to the requirement for Independent Engineer Verification and the impacts this would have on wider Industry.

National Grid Ventures have suggested that they intend to raise an alternative which would lessen the requirement for Independent Engineer Verification. Instead, they have suggested that this verification in in fact carried out by a suitable expert within a User's organisation, who is separate from the relevant project team. This view is reflective of that held by some workgroup members that whilst the robustness of the process is key, the need for an Independent Engineer is too onerous.

The workgroup is keen to take views from Industry in this consultation process on this matter, so the correct solutions which do not compromise robustness are taken forwards accordingly.

Compliance Repeat Plan

The Proposer highlighted that under his solution, enhanced robust compliance plan to ensure regular reviews of the Generator Compliance status are conducted on an ongoing basis. The concept of compliance repeat plan is contained in European Compliance Plan 8. Workgroup discussions and subsequent feedback outlined concerns over the requirement to re-validate simulation studies for every 5 years. Some Workgroup members felt repeat testing should be based on scenarios where the ESO highlight issues. Some Workgroup members felt that Compliance Repeat Plan should not be

made mandatory, as this would result in a loss of revenue for the operator. Further to workgroup feedback, and to facilitate this, the Proposer agreed that the ESO will notify the provider with a 6-month reminder to ensure compliance is met within the 5-year requirement.

The majority of the workgroup felt that the simulation studies are a part of the Compliance Process and not the Planning Code Data. The majority of the workgroup agreed significant changes should be notified, and that having a self-certification is the correct way forward, however if the network has changed then it is the ESO's responsibility to assess the network.

The proposer also clarified the requirements in order to clearly restrict the scope to re-submission of the data outlined in the Planning Code and the Data Registration Code rather than full simulations and tests present in the Compliance Process/European Compliance Processes.

The proposer also made clear that the Independent Engineer review requirement will not apply to the 5-year Compliance Repeat Plan.

The workgroup also raised concern around the practical implementation once the Grid Code has been changed as there will be a considerable number of power stations which have been operating for more than 5 years since compliance has been confirmed. The proposer agreed that the ESO should provide guidance on how the dates for older stations confirming continued compliance should be managed and spread so that portfolio users (and ESO) do not face an impractical "bow wave" of work.

The Original Solution details the proposal for the Compliance Repeat Plan. The workgroup would be interested in views on the robustness of the Original Proposal and any alternative ways forward from the Original Solution.

RMS and EMT Model Submission PC.A.9

The workgroup spent substantial time discussing both RMS and EMT models. This included discussions around the current use of both models and suitability moving forwards. The benefits of both models were discussed, and how this would impact the work on the modification.

The workgroup generally agreed to submission of RMS and EMT models. The Workgroup members questioned when sufficient information is to be provided and how it would apply to older sites with different connection dates or where information may not be obtainable. In response the proposer directed the workgroup to **PC.A.5.3.2** and **PC.A.5.4.2** which only require the information outlined in **PC.A.**9 for new or modified sites.

Following discussion, the working group generally supported using RMS wind farm models (based on international standards for example) to offset some of the concerns over sensitivity of manufacturer-specific information. The proposer has amended the emphasis of the drafting in **PC.A.9.3.4** towards using international standard models (e.g. IEC/WECC/IEEE models commonly available in proprietary software) to offset concerns over sensitivity of manufacture specific information. While submission would be in standard IEC/WECC/IEEE formats, the parameterisation should be appropriate for the connection site and not generic to bring the model performance in line with the real plant within the accuracy limitations of RMS models. The Work Group were had concerns that International standard models for some HVDC systems which can be more "bespoke" were less developed so may be more difficult to bring in line with their real plant

performance. This may also be true for other technologies emerging at the transmission level such as batteries and solar farms.

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Discussions around what level of detail the User has to provide with respect to "Sufficient information and when it will be provided by the User to allow for The Company to redevelop user defined RMS models (as opposed to industry standard models) in the event of future software environment changes or version updates" took place. Where a user defined RMS model is provided this needs to be open with visible transfer block diagrams which would be considered "sufficient."

The ESO and TO representatives re-iterated concerns that RMS models should be suitable to run in large network studies without extending simulation run times. This means high speed (small time constant) and complex control functions should be simplified to larger time constant representations applicable to 50Hz RMS modelling framework. The Proposer noted that any RMS models which would call on external or encrypted data cannot be used due to inherent risk to control centre operations.

The Workgroup discussed the confidentiality surrounding manufacturers intellectual property, particularly in relation to EMT models where very detailed representation of control systems is included. The proposer has provided Alternative wording of **PC.A.9.9.2** to allow the working group to consider encryption of EMT models with associated documentation on the functionality included in the model. The ESO/TO would publish a guidance document on the purposes to which EMT models would be put and specify some criteria such as step size, acceptable compliers to ensure compatibility in an extended network context[2].

The User community on the workgroup raised concerns over data provision from the ESO/TO to allow new connectees to ensure no interactions such as torsional or control system interactions (SSTI/SSCI). This revolves around the risk of an EMT model from manufacturer A being shared through a user to manufacturer B and then manufacturer B gaining knowledge and a competitive advantage. The proposal has been modified to allow encryption of EMT models to protect intellectual property and restricting any user in receipt of a model to only using for the stated purpose, noting the models will be provided specifically relevant for those purposes and not necessarily others. The proposal also includes alternatives either for the process of completing the studies or technological methods which might protect information. Further consideration of discussion on facilitating SSTI/SSCI studies is recorded in a separate section below.

The legal text for the Original Solution is in Annex 2 of this report. The workgroup spent much time considering the P.C.A.9 modelling requirements. A sub committee was formed within the workgroup to discuss this issue specifically. Their consideration of an alternative solution to the original, specifically in regards to P.C.A.9, on p17 of this report.

If you have any comment on the suggested amendments to the Planning Code the workgroup would like this fed through this consultation.

Provision of Shaft Data for SSTI Studies - PC.A.5.3

The workgroup also discussed in detail the requirement for shaft data from older synchronous plant necessary for ensuring that there is no risk of damage from SSTI. The

[2] Any guidance note would not be reviewed by public consultation

workgroup agreed that such data was essential. It was noted that the original proposal was that all existing generators should supply the information, but this was not favoured by owners of older plant. An alternative has been included for provision of data when required after screening studies by ESO/TO. In the unlikely event of an existing generator proves unable to procure the data for their plant this would require a derogation request in the same manner as other inabilities to comply with the Grid Code. In addition, under such circumstances, some of the workgroup members raised a concern that the studies would not include the data not provided and doesn't guarantee "no negative" impact on such Generators without data or when Generic data is used. The workgroup members also discussed that in circumstances where reasonable data is not available, there should be a discussion on how the study scope is to be revised.

The legal text is available for your review at Annex 2, and the workgroup would be interested to gather thoughts on the modelling as part of this consultation.

Fault Ride Through Wording (Connection Conditions/ECC)

Workgroup members held several discussions around repeatability requirements in terms of how many faults plant should be able to ride through whilst remaining stable, in what timeframe and how soon they should return to normal operation immediately after fault recovery. Comments around how to define 'immediately after' a fault were made by several workgroup members. After several iterations with workgroup members, the Proposer has revised the drafting of these clauses

Fault Ride Through Simulations (ECP)

Discussions around the requirements for Fault Ride Through Simulations indicated that the workgroup felt they were too open ended. As a result, the proposer made amendments to the scope of **ECP.A.3.5.3** stating that the **Generator** and **The Company** will agree on the nature of the content/studies prior to simulations commencing.

The proposer also added the specific provisions relating to complex HDVC systems within ECP.A.3.5.5 to ensure more appropriate requirements for a wider range of technologies.

Interactions - SSCI / SSTI

Concerns were raised regarding sub-synchronous control interaction (SSCI) and sub-synchronous torsional interaction (SSTI) simulation data availability. This data is required to assess potential risk to plant e.g. offshore developers typically require data from other users for risk mitigation purposes during planning phases. Discussion suggested ESO should conduct screening on oscillatory frequencies to check appropriateness before requesting such torsional data for existing plant, as it can be difficult and expensive to obtain. Additionally, the risk is typically only applicable to large converter-based plant.

For SSCI analysis there are various frequency domain screening and damping analysis techniques which can allow users to do a lot of controller tuning work and identify risk areas in quasi-steady state but to complete time domain, particularly large signal studies, models from another user's plant are required.

Proposer clarified that while the ESO is responsible for carrying out screening studies and that going forward the ESO should be able to identify where there is an operational risk of interactions, the ESO is not resourced to carry out studies to design controllers to avoid such interactions. As a result, the proposer has included several options within the

draft Legal Text for consideration by the workgroup; this is to ensure users are given appropriate options to consider how best to obtain this data.

National Grid Ventures shave suggested that they may raise an Alternative Solution on these issues. The workgroup would be interested to hear your feedback on this issue.

Consideration of other options

Workgroup discussions highlighted some different views on fundamental aspects of the proposed original solution and given the complex nature of these areas the workgroup agreed to form 3 sub committees to discuss alternatives. These alternative areas of discussion relate to the following topics:

- Independent Engineer
- Interoperability
- Modelling Appendix 9

Independent Engineer - Alternative

Potential revisions of wording around stipulations for the Independent Engineer and associated role specifics. The concept of "Independent" was to be reviewed along with consideration of whether a guidance note may be required.

Initial discussions resulted in the view that whilst the Original meets the objectives of the Grid Code, it is believed that this Alternative solution proposed offers additional advantages to the COMPANY and the USER.

Key discussion areas and outcomes are as follows:

- **Defining the role and skill set required;**
  - Focus on the skills required to provide the functionality, ensuring those conducting the role have no conflict of interest - leading to greater opportunity for cost effectiveness and lower cost to consumers. The group noted that a range of entities inclusive of independent entities within the User base, and the ESO and TSOs may be considered, which would limit additional cost of execution. Confirmation would be required that the terms of reference are met, and appropriate skills and resourcing are present.
- **Clarifying the process and responsibilities;**
  - To ensure a smoother, more efficient, process for the COMPANY and the USER. This clarity also allows the relevant resources to be identified and combined by the USER to fulfil the role on a project by project basis.
- **Suggested Terms of Reference for the role;**
  - Maintain a list of interests and ensure that delivery of the review and recommendations is objective and technically focused. The list is used for USER evaluation and COMPANY consultation ahead of being appointed.
  - Responsible for review and comment on the scope of analysis to be conducted to satisfy Grid Code and Bilateral Connection Agreement requirements. Comment on the fitness of data and models that form part of this process, highlighting any gaps and providing a view on assumptions being taken.

  - Review of the analysis reported on and provide specific recommendations on acceptability and or completeness in meeting the scope of the compliance activities.
  - Provide resource supporting the User's agreed programme of compliance activity and the Company's associated activities, provide timely feedback. If the outcome of the review impacts the compliance process programme the USER shall inform the COMPANY.
  - Manage confidentialities involved in discharging the above, in particular in the exchange of models and simulation results.
  - An Independent Engineer is not expected to redo the simulation studies (unless agreed by the User and ESO) but provide technical feedback on the validity of study assumptions, study approach and results.
  - The USER should maintain a clear auditable record of its interaction with the compliance process.
- **How to deliver against Terms of Reference;**
  - Clear definition of scope of the project under review
  - Complete, accurate and timely assessment of data from the COMPANY or USER being used to inform compliance activities, including those requiring suitable confidentiality management within the project.
  - Access to the program and milestones associated with the compliance process.
  - Access to all relevant meetings/ minutes/ discussions related to the compliance activities under review
- **Need for a guidance note – to cover:**
  - Aid the USER and avoid overly detailed and burdensome legal text.
  - Scope of the independent engineer i.e. template Terms of Reference and The Company's expectations to ensure consistency.
  - Responsibilities/liability of the independent engineer and their credentials/experience
  - Examples of typical information required to discharge duties correctly, e.g. case studies.
  - Studies not directly related to CP, ECP or OC5 e.g. harmonic studies, multi-infeed studies etc.
  - Dispute resolution procedures e.g. in the event of disagreements or failure to approve tests being considered unreasonable
  - How the independent engineer's fits into the interface between the Company and the User.
  - Process and timeline for onboarding and offboarding into/out of a project.
  - With respect to point 5 in the legal text provide an example of a sign off sheet
  - Provide non-exhaustive examples of what may require INDEPENDENT ENGINEER review during self-certification of the Grid Compliance process. Consideration shall be given to the substantial modification process with the ESO; this could be either large replanting or a cumulative effect of a number of smaller modifications.

Interactions SSCI/SSTI - Alternative

To discuss undue interactions such as SSCI and SSTI, Responsibilities for various parties (as part of a connection), and Signal Disturbance. The group also reviewed the Process concerns versus Responsibility Concerns and Consideration of Sub-Synchronous Interactions.

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An alternate in this area would address the following areas-

- Clearly defined roles and responsibilities with respect of the Company providing both data relating to the screening process which precedes interaction and the interaction study itself which can be summarised as;
    - The Company should use UIF techniques and other data such as knowledge of the scope of Harmonic transfer impedances used to define a projects' Harmonic background, and the extent to which projects are dynamically contributed in classical RMS studies to define both the study area and the range of operating cases a user should then consider within those studies.
    - The user is responsible for capturing the full extent of their connection in appropriate models suitable for the study and the range of operating conditions across which the users connection could be subject to, and then within the network models provided assessing relevant forms of interaction in suitable models or other tools appropriate to the form of analysis.
    - Consistent with historic analysis of interaction (for example Power System stabiliser design), it is recognised the above may not represent a complete description of all of the analysis necessary. The Company in receipt of both the user relevant models and its own relevant models is responsible for ensuring any broader planning considerations which arise from consideration of the users solution in a larger network model are reflected back to the user and that suitable solutions are found to address these considerations, which may include further discussions regarding user measures if more efficient and economic than other alternatives.
- Defining the processes of small signal stability assessment which combined with frequency scanning techniques can effectively identify a range of focused areas for further EMT dynamic simulation, thus avoiding hunting for "needles in a haystack" (as EMT studies are dependent on a much greater range of variables to classical RMS studies across which it is harder to identify interaction risk and verify solutions to it without analysis focused in different areas to just classical RMS techniques). Such frequency domain analysis may also provide sufficient information to provide assurance that SSTI and related SSO considerations at a given frequency include sufficient electrical and minimum mechanical damping (where such assumptions are available and relevant). In summary, such small signal techniques would need to be enabled in the following manner;
    - Each User should accompany its EMT model with a suitable suite of "Z plots"; frequency dependent impedance representations of power electronic converter connections across each of the relevant operating conditions for which these plots differ. Such plots shall be constructed by small signal techniques which capture the effect of relevant control and protection within the frequency domain, including the effects of both PPS and NPS control loops for give operating points and control modes. Such a Z plot should be detailed in a minimum of 0.5Hz increments between a minimum 0->200Hz, enlarged to include any other relevant frequencies as identified from other harmonic analysis where this is identified from other analysis the Company has access to from network planning activity associated with the connection.
    - The User conducting a frequency scan should similarly construct its Z plot from its EMT model following the above principles.
    - In order to support a connecting User undertaking a small signal interaction analysis, whether for SSTI or other reason, the user should for the network

area it presents and the relevant operating points of it and the connected sources, also provide the relevant Zplots of other users that correspond to those conditions enabling the associated analysis. For example we note the tendency for existing SSTI process to "jump" from a UIF measure which may be increasingly of limited relevance to modern forms of converter connection, to a dynamic simulation reflecting UIF considerations only and requiring additional shaft data- whereas correct use of small signal analysis may provide assurance without need for such shaft data, or otherwise where that assurance is insufficient at least better direct further dynamic simulation incorporating shaft information.

- Clear definitions consistent with Cigre B4.81 recommendations Annex 2efers), in order to ensure that
    - The necessary simplifications within EMT models as provided are oriented towards being fit for the defined purpose of the defined form of analysis intended.
    - The range and applicability of platforms for such analysis (offline EMT, real time analysis, real time Control & Protection Hardware in the Loop) is clear in relation to the definitions of study.
    - We note that it should be clear, at the outset of the detailed design phase of a project, the extent of analysis required, the formats of data exchange needed to support the analysis areas required and agreement on the appropriate analysis platforms to conduct them. In particular we note that Control &Protection Hardware In The Loop where required drives additional modelling and hardware that requires early definition to be delivered efficiently.
- With respect to current drafting we note that the company "may specify" Real time analysis for example with respect to protection. We recommend that with reference to the above definition this is made clearer that the Company "shall" where required by the definition of the required analysis both require and further justify realtime analysis ahead of the detailed design phase of a project.

RMS and EMT Modelling Appendix 9 Alternative

Discussions to consider interactions with interoperability challenges, use and sharing of models, simplification of the RMS model, validation of models against each other and consequence of simplification, technical buildup of models (criteria), future proofing, format and sharing of models

The group concluded that while the Original text provides a much-needed foundation for the development of the RMS and EMT control system models, the complexity of developing, updating and distributing such models requires some additional clarity and further detail to provide a more practical set of requirements and reduce the volume of project-level clarifications required.

Key discussion areas and outcomes are as follows:

- **Distribution of models**
    - More specifically, clarification is needed on the use of the models at the System operator level (e.g. assess the transient performance, security and stability of the Transmission System) as well as their distribution to other Users that must require the models for the purposes of Grid Code compliance and related studies. Additionally, Intellectual Property rights of the manufacturers need be protected while still ensuring the points above can be effectively addressed. In this regard, a separation of the

distribution requirements for the simplified RMS models and detailed encrypted EMT models would be seen as necessary based on their use and the studies to be executed by the relevant stakeholders. Additionally, the repository for the models (e.g. the Joint Planning Committee) should also be noted within this alternative

- **Simplification of the RMS model which doesn't use proprietary blocks or code**
    - Assessment is required on model performance where it would be impacted by the necessary simplification and proposed increased simulation time step of 10ms. The intention is not to specify a certain level of accuracy for the “simplified” model but to clarify that certain areas of the model and its subsequent performance (e.g. fault-infeed, TOV and/or fault recovery) may be affected. This will also impact the validation of models against EMT or RTDS results and expectations on accuracy. Overall, these impacts would require an assessment by the Company and User (and Independent Engineer where relevant) to determine how these areas are addressed such that the RMS model can be used for planning purpose without giving a falsely optimistic view of performance that could lead to EMT studies not being initiated at times when they would be advisable. The alternative to the above would be to provide an as-built proprietary RMS model representing the User system accurately.
- **Clarification of black-boxing wording to ensure consistency with industry**
    - Additionally, the issue of futureproofing and formatting of the models needs to be addressed in this context.
- **Rewording of PC.A.9.8 and PC.A.9.9 to facilitate practical implementation**
    - Parts of these sections may be better suited to a guidance document.

Draft Legal text

Legal text will be drafted after the Workgroup Consultation has been completed.

The draft legal text for this change can be found in Annex 2.

Please note the proposer has provided commentary within the draft legal text. This commentary will be removed ahead of the legal text being finalised.

What is the impact of this change?

Offshore Networks are designed in conjunction with the design of offshore generation so there may be the need to update STC Section K and STCP19-5 to align with the Grid Code proposals.

Proposer’s Assessment against Code Objectives

Impact of the modification on the applicable objectives:	
Relevant Objective	**Identified impact**
(a) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity	**Positive/Negative/None:** None
(b) Facilitating effective competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);	**Positive/Negative/None:** None
(c) Subject to sub-paragraphs (a) and (b), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole;	**Positive/Negative/None:** Positive - to address concerns raised by Ofgem and BEIS
(d) To efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency; and	**Positive/Negative/None:** Positive
(e) To promote efficiency in the implementation and administration of the Grid Code arrangements	**Positive/Negative/None:** None

Standard Workgroup Consultation question: Do you believe that the Grid Code Original proposal better facilitates the Applicable Grid Code Objectives?

When will this change take place?

Implementation date:

Suggested Date 1 October 2021.

Date decision required by:

Suggested date decision from Ofgem 20 August 2021.

Standard Workgroup Consultation question: Do you support the implementation approach?

How to respond

The Workgroup is seeking the views of Grid Code Users and other interested parties in relation to the issues noted in this document and specifically in response to the questions above.

Please send your response to grid.code@nationalgrideso.com using the response pro-forma which can be found on the GC0141 modification page.

In accordance with Governance Rules if you wish to raise a Workgroup Consultation Alternative Request please fill in the form which you can find at the above link.

If you wish to submit a confidential response, please note that information provided in response to this consultation will be published on National Grid ESO's website unless the response is clearly marked "Private & Confidential", we will contact you to establish the extent of the confidentiality. A response marked "Private & Confidential" will be disclosed to the Authority in full but, unless agreed otherwise, will not be shared with the CUSC Modifications Panel or the industry and may therefore not influence the debate to the same extent as a non-confidential response. Please note an automatic confidentiality disclaimer generated by your IT System will not in itself, mean that your response is treated as if it had been marked "Private and Confidential".

Standard Workgroup Consultation questions:

1. Do you believe that GC0141 Original proposal better facilitates the Applicable GC0141 Objectives?
2. Do you support the proposed implementation approach?
3. Do you have any other comments?
4. Do you wish to raise a Workgroup Consultation Alternative request for the Workgroup to consider?

Specific Workgroup Consultation questions:

Independent Engineer

5. What should the Independent Engineer's deliverables be with respect to the outcome of the compliance process?
6. Should there be specific requirements on the retention of data for the User and/or the ESO?
7. Should the detailed design stage be more clearly identified within the Grid Code?
8. What stages of implementation would the industry believe are appropriate?
9. Should the ESO be required to undertake the responsibilities associated with an independent engineer? Please outline your rationale.
10. Should there be greater definition be given to "substantial modification" given that the self-certification process places the onerous on the User to make these decisions?
11. Should there be a review of the effectiveness of GC0141 post implementation and after the industry has experience of implementing?

Compliance Repeat Plan

12. What are your thoughts on the workgroup's discussions regarding compliance repeat plan? How would this work in regard to Independent Engineer Verification?

Interaction - SSCI/SSTI

13. Do you believe that screening processes should be applied ahead of detailed dynamic EMT simulation, and if so, do you believe data exchange should support that?

14. Do you agree that the roles and responsibilities associated with interaction studies should be detailed and clarified, and to what extent?

15. Do you agree that improved definitions of the types of analysis and definitions suitable analysis environments ahead of the detailed design phase provides useful clarity and minimised project disruption in delivering the principles of this grid code change? Should these form part of legal text or made available with the modification as guidance that may be separately updated from time to time?

16. Do you agree that clarifying roles and responsibility in the management of interaction studies assists more clearly defining the analysis needs of each party, minimising confusion, unnecessary overlap and cost in the design phase?

17. Do you agree that small signal analysis supporting the screening of interaction cases should be clearly specified within this grid code change, to better focus the range of EMT studies being discussed, and within the context of existing SSTI and SSO analysis better inform assessment of risks and the need for detailed dynamic simulation which includes shaft data for SSTI?

RMS & EMT Modelling Appendix 9

18. What is your view on the separation of the simplified RMS model and EMT model when it comes to confidentiality, distribution and the protection of IP?

19. As it currently stands, what is your view on the process by which detailed manufacturer EMT-type models are exchanged for necessary studies as part of project delivery?

20. Are sections PCA.9.8 and PC.A.9.9 better suited to a guidance document and or should they be included, at least partly, within the legal text? Are there any specific concerns with respect to requirements set out within those sections?

21. In terms of the requirement for existing users to provide sub-synchronous torsional data for existing plant that may be provided, do you see any issues in regard to the provision of this data?

22. Should responsibility for interoperability remain with the generator or the ESO, inclusive of interoperability studies such as control interactions and SSCI/SSTI studies? Please provide your reasoning.

Interaction -SSCI/SSTI

Acronyms, key terms and reference material

Acronym / key term	Meaning
Baseline	The code/standard as it is currently
CP	Compliance process
ECP	European Compliance Process
EMT	Electromagnetic Time domain
FRTS	Fault Ride Through Simulations
HDVC	High Voltage Direct current
SSCI	Sub-synchronous Control Interaction
SSTI	Sub-synchronous Torsional Interaction
STC	System Operator Transmission Owner Code

Reference material:

1. Guidance Notes covering the demonstration of compliance for Power Park Modules, Synchronous Generators and HVDC Interconnectors under both EU Code and GB Code can be found on the National Grid ESO website under Grid Code, Associated Documents: https://www.nationalgrideso.com/industry-information/codes/grid-code-old?code-documents=

2. Commission Regulation (EU) 2016/631 of 14 April 2016 and Commission Regulation (EU) 2016/1447 of 26 August 2016.
   https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN

   https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1447&from=EN

3. 9th August 2019 Power Outage Report published by Ofgem dated 3rd January 2020.
   https://www.ofgem.gov.uk/system/files/docs/2020/01/9_august_2019_power_outage_report.pdf

4. GB Power System disruption on 9 August 2019, Energy Emergencies Executive Committee (E3C) Final Report published by Department for Business, Energy and Industrial Strategy, published January 2020.

   https://www.gov.uk/government/publications/great-britain-power-system-disruption-review

Annexes

Annex	Information
Annex 1	GC0141 Proposal Form
Annex 2	Legal Text
Annex 3	Terms of Reference